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GRACE Project: model-based control of a nonlinear actuator

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Published in:
 Benelux Meeting of Systems and Control

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
 Final author's version (accepted by publisher, after peer review)

Publication date:
 2019

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Fonseca Aguilar, O., Muñoz Arias, M., & Stavenga, D. (2019). GRACE Project: model-based control of a nonlinear actuator. In *Benelux Meeting of Systems and Control* (2019 ed.). KU Leuven.

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GRACE Project: model-based control of a nonlinear actuator

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1 Introduction

Natural phenomena have proven to be a great source of inspiration for developing specialized devices. Insect compound eyes offer promising insights for the development of new artificial navigation and vision systems [5]. In recent years, a Goniometric Research Apparatus for Compound Eyes (GRACE) has been developed. The aim of the apparatus is to obtain a rapid mapping of compound eyes. Initially a non-automatized system was used [4], [5]. The apparatus has been automatized into a specialized mechatronical device with 6 degrees of freedom, with an upper and lower optical stage and a digital camera (Figure 1). In the last upgrade an auto-focusing algorithm sets the position of the studied insect using the sharpness of the image by controlling the position of Motor Z. Motors X and Y adjust the lateral position, depending on the image details. To control the position of the camera system, which is attached to a Zeiss microscope in the upper stage, a highly nonlinear actuator for a Elero DC motor has been developed. The actuator holds the microscope, which, due to a lead screw, is severely affected by gravity and a high friction coefficient. An energy-based model is here applied using the port-Hamiltonian framework (pH), taking the mass of the system in the screw as an external force, and based on the self-locking property [1]. An optical rotational encoder is the sensor used in the actuator. The proposed controller is a dynamical extension based on the results of [2]. Experimental results can be obtained with a longitudinal accuracy of the microscope position of 5 μ m. The developed GRACE system allows the massive collection of detailed images of insect eyes, i.e. of flies and butterflies.

2 Experimental setup

The GRACE system is shown in Figure 1. First, the M axis is in repose when the DC motor is not powered. The aforementioned is due to the motion transformation mechanism, a lead screw presents a nonlinear behavior, dependant of the direction of motion and friction. The above is considered as an external force entering the rotational system.

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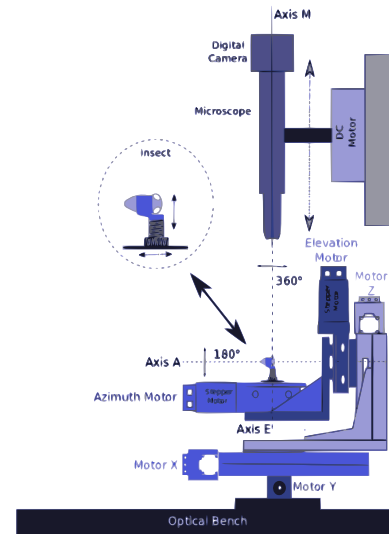


Figure 1: Schematics of the GRACE system at University of Groningen [3].

Hill.

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